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From expert judgment to model based monetary analysis: the case of the Dutch Central Bank in the postwar period

Frank A.G. den Butter and Harro Maas¹

Abstract

This paper investigates the history of the shift from expert to model based monetary policy analysis at the Dutch Central Bank (DNB) in the postwar period up to the middle of the nineteen-eighties. For reasons that will become clear expert based reasoning at DNB was referred to as normative impulse analysis. Our focus is on two aspects of this shift: (i) from an expert based monetary analysis to a model based analysis of channels of monetary transmission, and (ii) from the top down way of monetary analysis where the president of DNB acted as the monetary expert that was in line with the hierarchical organisation of DNB to the bottom up modelling approach that was set up by a group of newly hired young academic outsiders and destabilized DNB's organisation. The resulting econometric model enabled DNB to regain some of its argumentative strength in the Dutch policy arena that had become dominated by the econometric model of the Dutch Planning Bureau (of which Tinbergen was the first director), but also led to tensions within DNB's organisation. In spite of efforts to incorporate the main aspects of Holtrop's monetary analysis within the model, its concomitant new research group appeared difficult to integrate within the hierarchical organisation of DNB. The model analysis resulted in the MORKMON model which replaced Holtrop's analysis in the mid 1980s and was regularly used in policy analysis and forecasting of DNB until 2011, when the model was replaced by the DELFI model.

Keywords: Dutch monetarism, history of economic modelling, monetary policy

JEL-codes: B23, C52, E58

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1. Introduction

In 1969 dr. W.F. Duisenberg advised the Governing Board of the Nederlandsche Bank (DNB), the Dutch central bank, to release a group of research staff from their day-to-day routine to perform systematic econometric research on monetary issues. After his return to the Netherlands from the United States as staff member of the IMF, Duisenberg was added as advisor to the Board where he found himself confronted with a strong tradition of analysing monetary phenomena set up by dr. M.W. Holtrop who had been Governor (“President”) of the Bank in the period 1946-1967. Duisenberg assisted the Bank’s former president in estimating an econometric version of his monetary analysis (published as Holtrop, 1972a), but he was shocked by the Bank’s lack of knowledge of modern monetary economics and econometrics that could meet international standards and that he was acquainted with at the IMF. This motivated his advice.

In 1970 Duisenberg left the Bank to become professor of economics at the University of Amsterdam, and somewhat later Minister of Finance. But his advice resulted in the establishment of the Econometric Research and Special Studies Section of the Bank’s research department that was largely recruited from outside of the Bank. The task of this group of young economists and econometricians, with dr. M.M.G. Fase at its head, was to provide the Bank with modern insights from economic theory and with a model based analysis in the Dutch tradition of Tinbergen, that could eventually replace Holtrop’s monetary analysis. This task was, in a way, completed in the mid 1980’s with the publication of the first version of the MORKMON model (De Nederlandsche Bank, 1984, 1985, Den Butter, 1988). MORKMON is an acronym (in Dutch) for Monetary Real Quarterly Model for the Netherlands. Again it was Duisenberg, but now as Governor of the Bank, who was involved in this shift from the old to a new monetary analysis.

This paper discusses the transition from Holtrop’s normative monetary analysis to a model based policy analysis from two perspectives. First, from the perspective of the history of economic thought and secondly, from the organizational perspective of how a top down oriented setup of policy preparation was replaced with a bottom up designed method in the very hierarchical setting of the central bank of those days.

Holtrop’s analysis was firmly rooted in the Interwar tradition of the theory on the neutrality of money and aimed to identify the sources of disturbances that could bring the economy out of equilibrium. Holtrop’s monetary analysis found its roots in monetary debates in the interwar period that can be traced to the notion of ‘neutral money’. Holtrop’s analysis still provided guidance for monetary policy after Dr. J. Zijlstra, a former Prime Minister of the

Netherlands, succeeded him in 1967. Holtrop's analysis was known as his 'normative impulse analysis'. It was normative in that he aimed at sterilizing these disturbances as much as possible so that inflationary pressure were avoided. Internationally, Holtrop's theory, that was exclusively concerned with influences of the monetary sector on the economy, was referred to as Dutch monetarism.

Econometric models from the 1950's to the 1970's, in the Netherlands and in the rest of the world mainly focused on the real sector of the economy. The task of the newly appointed young academics in the research department of the Bank was to add a monetary sector to such models and pay ample attention to the channels of monetary transmission. Two roads were followed to try and get these new and unknown ideas and techniques accepted by the older staff and research management of the bank. The first road was to seek academic recognition by publishing research output in the main international and Dutch academic journals. The second road was to link the new econometric model, in which economic mechanisms were explicitly modelled by means of behavioural equations, as much as possible to the concepts used in Holtrop's normative analysis.

We proceed as follows. The next section contains a review of the theoretical background and practical policy use of Holtrop's normative analysis. Attention is paid to the academic discussions between Holtrop and others in the literature. Section 3 shows what steps were taken in order to come to a model based alternative to Holtrop's analysis. The problems on how to get this new approach accepted with management and senior staff used to the Holtrop tradition are discussed in section 4. Section 5 concludes.

2. Holtrop's normative analysis

A top down approach

Marius Holtrop took offices as governor of the Central Bank in 1946. Before the war Holtrop had worked in business, of which some three years for Shell Company in San Francisco. During the war he had been one of the directors of the Dutch Steel company Hoogovens. After the war, the Minister of Finance Liefstinck offered Holtrop, of unspoken behaviour during the war, to become governor of the Central Bank. One might wonder why this post was offered to someone from the world of business. But Holtrop combined a background in business with strong academic credentials in monetary analysis, which made him, in the eyes of Liefstinck, the perfect candidate for the difficult task that was ahead of him.

In the interwar period, Holtrop studied economics in Amsterdam and he was the first student to continue his studies at the City University of Amsterdam (now University of Amsterdam) for a PhD-thesis in the economics department. His supervisor was professor Herman Frijda

and his thesis subject was the velocity of money (Holtrop, 1928). After a historical review of the troops, Holtrop examined current theoretical debates. He extensively discussed the Cambridge version of the quantity theory $M = kPT$, that emphasized motives for holding cash-balances and (dis)hoarding, a discussion that would be of consequence for his later monetary analysis. Holtrop considered his investigation into the liquidity preference of the different actors in the economy an investigation into the different behavioural causes influencing the velocity of money. The bend of the thesis was theoretical rather than empirical; no attempt was made to measure the velocity of money (or any other relevant monetary concept). Looking back in the early fifties, Holtrop considered his thesis contribution to consist in the application of insights from the field of business economics to the field of monetary theory.

One of the main influences on his monetary thinking in this period was the Dutch monetary economist Johan Gerbrand Koopmans, who was a strong advocate of the idea of ‘neutral money’.² This idea, that we will explain in more detail below, meant that changes in the money supply should not disturb the demand and supply of goods and services in the economy. After having defended his thesis in 1928 Holtrop solicited for a position at the DNB, but unsuccessfully, after which he moved into the world of business.

After the war one of the major tasks of the Bank was the normalisation of the monetary system. Holtrop had to start almost from scratch. He was keenly aware of the importance of a research department and hired Cornelis Goedhart, a monetary economist who was also deeply influenced by the monetary analysis of Koopmans. As Holtrop’s biographer Wim Vanthoor (1993, 76) puts it, Holtrop and Goedhart spoke the same language. After Goedhart’s appointment as full professor at the University of Amsterdam in 1952, Geldolph Adriaan (Dolf) Kessler, son of the president of the Dutch Steel company Holtrop worked for during the war, took over as head of research. The tandem Holtrop-Kessler would dominate monetary analysis at the Bank throughout Holtrop’s entire presidency - Kessler himself would retire halfway the 1980s but left the research department much earlier to become one of the Bank’s directors. Yet, as director responsible for research he kept a keen interest in the work of the department and became the main intermediary between the new type of econometric research and the tradition of monetary analysis at the Bank.

Holtrop was an impressive and dominant personality, son of a family of actors. He was very charming, but all of a sudden could change mood. He was not only very much in command, but also wanted to be in control. When walking through the premises of the Bank, he knew where the offices of all of the staff and their assistants were located, and would comment

² Johan Gerbrand Koopmans is unrelated to the internationally better known Tjalling C. Koopmans, PhD student of Tinbergen, second director of the Cowles Commission, and Nobel Memorial Prize Laureate in economics.

when he found somebody out of his or her office. Internationally he was much respected as an economist who was both leading in the theoretical field of monetary economics in the postwar period, and in applying theory to monetary policy. In 1946 Holtrop became member of the Board of Directors of the Bank for International Settlements (BIS) in Basle, Switzerland, where he was elected President in 1958. Meetings of the Board provided occasions for the governors of central banks to informally discuss matters of monetary theory and policy. Holtrop became a very active discussant in these evening gatherings in front of an open wood fire in Hotel Euler in Basle. More formally he was invited in 1958 to give evidence before the Radcliffe Committee in the UK, and in 1962 before the Royal Commission on Banking and Finance of Canada. His reputation as a leading monetary economist was confirmed by his election as Fellow of the Royal Academy of Sciences in the Netherlands. Holtrop, a man of business with an academic background and interest, became in the postwar period an internationally highly esteemed central banker with academic cachet. In the Dutch context, to question his judgment was to question his authority as a central banker.

Holtrop's academic and international stature was reflected in the hierarchical organization of the Bank. It was Holtrop who decided on monetary policy and it was Holtrop who crafted the theoretical arguments in support. As we will see, there were ample discussions about Holtrop's monetary analysis, but discussants came from outside the Bank, and mostly from academia. Within the Bank, Holtrop used Goedhart and later Kessler as his sparring partners in designing and extending the analysis and policy framework. Johan Koopmans once described Holtrop's way of working as that of a detective. Sparring with Goedhart or Kessler, Holtrop looked for clues in the statistical and other materials to probe into the causal chain of monetary events over the past year.

In this period the econometric models constructed at the official Dutch institute for economic policy preparation, the Central Planning Bureau (CPB), headed by first Nobel memorial prize Laureate Jan Tinbergen, increasingly became the platform for socio-economic policy preparation of the Dutch government. But Holtrop referred derogatory to its "silly behavioural equations" and far too optimistic and short-sighted forecasts, that he in platforms for Dutch economic policy preparation such as the Social Economic Council balanced with his more pessimistic judgment of past and future events. The task of the staff members of the Bank was to give precision to Holtrop's judgment, and to see to it that statistical data were collected in a format that matched the concepts of his analysis (see e.g. Van Straaten, 1989). In short, monetary theory and practice was developed top down at the Bank. Inside and outside of the Bank, the saying was that "Holtrop was the Bank, and the Bank was Holtrop".

There is evidence that even within the Bank Holtrop's monetary analysis as well as his dominant top down way of working was not unquestioned. After he stepped down, a window opened to alter the Bank's monetary analysis. By then, in 1967, it was more generally considered that the earlier internationally advanced research position of the Bank had been lost and that the Bank had lost credibility within the Dutch policy landscape as well to the Central Planning Bureau and its econometric models. The new Board of DNB clearly felt the need to innovate.

Thus, Duisenberg's advice, to establish a new econometric section at the Bank that would be in line with international developments, received favourable hearing. It became the task of Fase's team, which for the occasion we label ESS (the Econometric Studies Section), to use this opportunity and bring the monetary analysis and policies of the Bank in line with up to date economic theory and econometric methods. Holtrop's resistance against econometric modelling had become part of the research culture of DNB and so this proved an uphill struggle. Before we turn to the work of ESS, we will first detail the monetary analysis that developed under Holtrop's presidency.

Dutch monetary analysis in the interwar period

Holtrop's monetary analysis is commonly referred to as 'Dutch monetarism' (Selden 1975). Fase (1994) showed that this tradition goes back to discussions in the interwar period on the neutrality of money for which some smaller papers of Schumpeter and the Austrian school of economics more at large were particularly important. Dutch monetarism got its initial shape in the work of the Dutch economist Johan Koopmans. Following Fase's account Koopmans developed a monetary analysis that hinged on the notion of "neutral money". For Koopmans, the benchmark to understand the influence of money on an economy was an (imaginary) barter economy in which of necessity there is equivalence between supply and demand. Once money is introduced this equivalence no longer holds and so may lead to situations of excess demand or supply. These in their turn cause for inflationary or deflationary pressures on the general price level. The purpose of monetary policy, in Koopmans's views, was to regulate the money supply to ensure parallelism between the flows of money and goods (Fase 1994, 24). If that were the case money would play a neutral role in the economy.

Whatever its merits may have been, Koopmans's ideas were widely debated in the interwar period, amongst others by Jan Tinbergen, Gerard Marius Verrijn Stuart and Robert van Genechten. Coordinates of this discussion were the "inner value of money" (Verrijn Stuart), the narrowness and incompleteness of Koopmans's analysis of a money economy (Tinbergen), and the appropriate indicator to measure the neutrality of money (Van Genechten). This last discussion zoomed in on how to measure a stable money flow and what price index was most appropriate to indicate the value of money. In the interwar period

these questions did not come to a satisfactory conclusion. After the war Holtrop's major contribution was the development of an operational criterion for Koopmans's concept of the neutrality of money. This criterion shaped Dutch monetary politics in the post-war era.

The neutrality of money and monetary equilibrium

The annual reports of the Central Bank reflect this development. Holtrop defined a neutral functioning of a money economy as a situation of monetary equilibrium where money creation and dishoarding were in equilibrium with their counterparts. Each monetary report contained a section on monetary developments over the previous year. The first drafts of this section were written by Holtrop in person and carefully policed by him in a go-between with the research department. In this section Holtrop tried to identify what sectors in the economy could be held "responsible" for a disruption of monetary equilibrium and to what extent. In his quest for responsibility Holtrop distinguished between disruptions that were "autonomous" and "induced". For example, dishoarding by the private sector might be the result of a change within that sector or might be the inevitable consequence of actions that were imposed from outside upon the private sector. In the first case Holtrop considered the impulse autonomous, in the second induced. 'Impulse' thus was a generic term that indicated a behavioural response of a particular sector in the economy. The decomposition of the nature of this response depended on Holtrop's and the research department's yearly assessment of some fundamental statistics that were collected within the Bank's research department or by institutes such as the Central Bureau of Statistics in The Hague. The policy aim of the analysis was to come to a target for the money stock, and so to a target for liquidity creation by the banks, so that the ratio between liquidities and nominal national income would remain constant. Thus, money supply and national product should grow in the same rate so that, given the liquidity preferences of all sectors in the economy neither dearth or abundance of money would disrupt the flow of transactions.

In particular, this analysis made the liquidity ratio (or velocity of money) of central importance in Holtrop's decisions on monetary policy: in case of a too rapid rise of the liquidity ratio above some target level, banks in the Netherlands were confronted with direct credit restrictions, which limited their scope for (further) liquidity creation. From a macro-perspective, during Holtrop's presidency, this policy of direct credit restriction has been used to combat inflation (the "official" macro-economic task of the Bank), and for stabilisation policy (see Fase and Den Butter, 1977). Parts of Holtrop's monetary analysis, derived from the concept of the neutrality of money, have been preserved as guiding principles in the actual monetary policy of DNB after he stepped down as president. This is especially true for the so called causes or sources of money creation, which distinguished between autonomous monetary impulses and monetary impulses which could be regulated and fixed by policy.

Because of their practical relevance for monetary policy these parts - liquidity ratio and causes of money creation - of Holtrop's monetary analysis were used as stepping stones to link his analysis to the model based set up of the monetary analysis that the team of Fase was asked to develop. More specifically, three elements of Holtrop's way of looking at monetary equilibrium and possible disturbances were considered important: (i) the modelling of monetary impulses and their role in monetary transmission (the IS-curve), (ii) the use of the liquidity ratio and its connection with money demand (feedback mechanisms from the real economy), and (iii) the allocation of liquidity creation to various sources. The latter provided a clue which items on the sector balance sheets had to be explained by behavioural equations in the monetary model. The role of these parts in Holtrop's analysis is shortly discussed in the next subsections.

Monetary impulses

Holtrop's analysis of monetary impulses did not aim at *explaining* movements in major macroeconomic aggregates such as income and the balance of payments. It merely served to indicate what monetary conditions enabled the movements of such aggregates and to localize disturbances of a monetary nature. The analysis served diagnostic purposes. That is why Kessler (1972) called the Bank's analysis a condition model as contrasted to a causal model. Holtrop's formal statement of his analysis did not include behavioural equations, even though it included assumptions on normal values for holding cash balances and for the import ratio. Formally stated, the model consisted solely of identities representing equilibrium conditions that could be used to calculate monetary disturbances. Such a formal statement was not set up in terms of exogenous and endogenous variables and even on the number of equations no explicit information could be found in Holtrop's description of it. If one thinks about this model as stating the conditions of monetary equilibrium, it is not of much importance to know which variables are endogenous and which are exogenous. As the equations do not suggest the direction of causality and are merely identities, rewriting the identities is merely reformulating the equilibrium conditions.

Holtrop's model basically consisted of 4 identities (or monetary condition equations) :

$$\Delta L = Lcr + B \quad (1)$$

$$Lact = k\Delta Y + \Delta L \quad (2)$$

$$D = Lcr + Lact \quad (3)$$

$$E = B + \Delta M, \text{ where } \Delta M = m\Delta Y \quad (4)$$

In equation (1) the change in the money stock, ΔL is calculated as the sum of domestic liquidity creation, Lcr , and the inflow of money from abroad, B . Here B represents the national liquidity surplus which stems from the balance of payments position. Equation (1) can be considered a simple money supply equation. Equation (2) determines liquidity

activation, L_{act} , as the sum of money needed from the perspective of the demand for money ($k\Delta Y$) and the change in the money supply. Here Y is income and $k = L_{t-1}/Y_{t-1}$ the liquidity ratio from the previous period representing a kind of normative equilibrium money demand elasticity. Equation (3) gives the domestic monetary impulse, D , as sum of domestic liquidity creation and domestic liquidity activation. Finally, equation (4) determines the external monetary impulse, E , which is equal to inflow of money from abroad plus the change in imports from the current year (ΔM), derived from a simple import equation where m is the marginal import ratio. This correction of E with ΔM has to do with Holtrop's assumption that an outflow of liquidities to other countries induced by a rise in income, comes to an end after 12 months, for instance because by then exports have increased sufficiently (see Kessler, 1972).³

In a paper read to the Royal Netherlands Academy of Sciences, in September 1970, after his retirement, Holtrop tried to measure the effects of the monetary impulses on changes on national income by means of regression analysis (published as Holtrop, 1972). This can be considered an attempt to explicitly estimate the behavioural aspects of his monetary analysis, and Duisenberg, as mentioned before, helped Holtrop to run the regressions. This empirical extension of the Holtrop model showed some similarity with the small empirical model of the Federal Reserve Bank of St. Louis of the 1960s and 1970s, where changes in income are explained by monetary and fiscal impulses (see e.g., Kuné, 1972). However, Holtrop did not consider fiscal impulses, but only investigated the influence of autonomous and induced monetary impulses on income changes.

Liquidity ratio as monetary indicator

As we saw above, the main concern of Holtrop's monetary analysis was the responsibility of the central bank to keep domestic liquidity creation in line with money demand. During Holtrop's governorship, and considerable time afterwards, the liquidity ratio (as the inverse of the income velocity of money) acted as the main indicator and target for monetary policy. The liquidity ratio was thus of much more importance for monetary policy than the interest rate. It should be noted that in the postwar period discussed here, there was not yet a direct inflation targeting of monetary policy, but monetary policy was mainly directed at intermediate targeting. The use of the liquidity ratio in practical monetary policy in the Netherlands in those days boiled down to the simple rule that, when the increase of the

³ This way of calculating the external impulse had been subject of extensive discussions with J.J. Polak (see Polak 1957, Polak and Boissonneault, 1960). Polak was a former assistant to Tinbergen for his work on business cycles at the League of Nations end of the 1930s. As head of research at the IMF Polak had developed a small model that was very similar in outlook to that of Holtrop, but did not use the notion of equilibrium nor limited the effects of monetary impulses to one year (see also Polak, 1998).

liquidity ratio was considered too high compared to the equilibrium condition, banks were asked to restrain their domestic liquidity creation. Occasionally this request had the form of a direct credit restriction.

The rationale behind this rule related to the normal, or non-inflationary, demand for liquidities resulting from the transactions motive. Holtrop called this motive the *liquidity requirement*. Obviously, it was of great importance to possess reliable and “correct” data on the liquidity ratio, as this ratio played such a decisive role in monetary policy. The first issue to decide upon, therefore, was the definition of money (or liquidity). First, liquidity at the macro-level was defined as M1: coins, banknotes and demand deposits. But Holtrop would soon prefer a broader concept of money, namely M2, including secondary liquid assets such as time deposits and foreign currency holdings. During and after Holtrop’s presidency, there were long discussions in the staff of the Bank whether to include savings deposit in the money definition. Money including all savings deposits is labelled as M3. However, in the analysis of the Bank a distinction was made between “genuine savings” to be included in M3, and “liquid savings” with banks that were part of M2. The velocity of circulation of these savings was the separating criterion. A second issue was the fact that in the liquidity ratio L/Y , the money stock L is a stock variable, measured e.g. at the end of a time period, but the income Y is a flow variable, measured over a whole time period. Yet, for a proper “nowcast” of the liquidity ratio a measure of Y at the end of the period was required. Therefore great efforts were made by the statisticians of the Bank to come up with a pseudo “end of period” estimate of Y . A serious complication of this rule is that the use of the liquidity ratio as a compass in monetary analysis implicitly assumes an income elasticity of the required and desired demand for money of unity.

Sources of liquidity creation

Initially, Holtrop’s monetary impulse analysis moved by tables and graphs. From 1948 the Annual Report’s section on monetary and financial developments contained a table listing the “causes” of change of the domestic money supply. These causes referred to relevant sectors of the economy, such as central and lower government, the private sector (firms and households), the banking sector and the foreign sector. The statistical data in the tables largely follow from the accounts of the sectors, but where necessary were completed with estimates. This table with ‘causes’ or ‘sources’ of money creation were even in the 1990’s still published in the Annual Reports and Quarterly Statistics of the Netherlands Bank. The table distinguishes four main sources:

1. Liquidity creation on behalf of public authorities;
2. Liquidity creation arising from net money creating operations of the banks;
3. Inflows of liquidity from abroad to the non-monetary sectors- the so called liquidity surplus;
4. Miscellaneous items.

The combination of balance sheet items attributed money creation, and in a sense the responsibility for money creation, to three different sectors, namely (i) the government, (ii) the banking sector and (iii) the foreign sector. The miscellaneous item is a residual in the set up of the table. These four sources register the relevant *changes* in the counterparts of the domestic money supply in the aggregated balance sheet of the money creating institutions (banks plus central bank). The four respective counterparts are (a) public authority floating debt, (b) the so-called net money-creating operations, (c) the net foreign assets including the official gold and exchange holdings of the Netherlands bank, and (d) the balance of various assets and liabilities of banks. The latter counterpart is mainly composed of items in transit (float) and of aggregated net profits of banks.

3. Model based monetary analysis

The bottom up approach

When Fase was hired by the Bank in 1971 to set up a team which, following Duisenberg's recommendation, was to conduct empirical research in accordance with modern scientific standards, this implied a radical change in the administrative and research culture at the Bank. No longer was monetary analysis developed top down, with the Governor of the Bank as intellectual father, but now the team of young academics and outsiders to the culture of the Bank was given the task to perform monetary analysis.

One of the main problems the new team faced was how to familiarize the existing research management of the Bank and the senior staff members with this new bottom up approach. For ESS it was a challenge to have the monetary model specified in such a way that the sources of liquidity creation distinguished by the Bank could be explained by behavioural equations so that the model shed light on the underlying causes of money creation. It would also imply that the model could show how undesired money creation from one of the sources could be reduced or compensated using the instruments of monetary policy. This opened an important opportunity to link the structural model based analysis to Holtrop's conditional monetary analysis and to obtain support from the senior staff at the bank for the econometric approach.

The benchmark for econometric modelling in the Netherlands was set by the models of the Central Planning Bureau (CPB), which were in the 1970's still completely in line with the Tinbergen tradition of policy modelling. It was therefore natural that some of the newly hired ESS members were econometricians familiar with the techniques of economic modelling and time series analysis in the Tinbergen tradition. It was also natural that the team would 'look at' the modelling practice at the CPB to learn the necessary skills and techniques for developing an in-house econometric model. Yet, there would be differences in the skills and techniques required for building the Bank's model, because the model of the

CPB did not include a monetary or financial sector (which were – and still are - notoriously hard to model).

The pilot studies

To learn and adapt these skills, in the first years of ESS a number of pilot studies was conducted, which made the team familiar with empirical modelling of monetary phenomena. In addition, empirical models constructed at other central banks with a financial sector were studied. The forerunners in those days were the Bank of Canada (Helliwell et al., 1971) and the Banca d'Italia (Fazio et al., 1970). The team also looked at the models of the CPB to learn how to make model simulations for policy purposes, a model use that was high on the list of the management of the Bank. For that reason the team set out to *replicate* the quarterly model that had been developed at the CPB in the beginning of the 1970s by Wim Driehuis (see Fase et al., 1976). This model was used as a foil to learn about the practical difficulties of data-management and computational problems and to cope with abstruse issues that emerged when crafting a structural model for internal use of the Bank. Of course, it also involved some discussion with the staff of the CPB. An important task was the development of in-house software that would allow the group to perform simulation exercises on the model. The FORTRAN-compiler of the Bank's NCR computer turned out to be so unreliable that remote access was established with the CDC computer at the Energy Research Centre, which was designed for scientific calculations and which was also used by the CPB.⁴

One of the “disappointments” of this exercise with the Driehuis-model was that it turned out to be impossible to replicate the original results of the model. This was because the data-material Driehuis had worked with was in the possession of the CPB and not available to the public. Also, the CPB had re-estimated some of the equations of the original model on a data set with a different base year, and ESS had to use these data for their exercises. Despite these difficulties, the exercise showed that the lag-structure of the CPB model was ill-motivated, whereas these lags were of great importance in assessing the effectiveness of different policy measures within the model context. ESS was also sceptical about the claim that the CPB model was based on “micro-foundations” and suggested a more pragmatic and eclectic attitude instead. The team's view was that one should not overstretch expectations with regard to “theory” and use theory to “order thinking” (Fase et al., 1976). A major reason to consider the Driehuis-model was that it was based on quarterly data. ESS had decided to use quarterly data for its empirical analyses whenever possible and also to eventually build a quarterly model. That was also in line with the needs of the Bank as it published from 1968 onwards besides the traditional Annual Reports also Quarterly Bulletins, containing quarterly data of the major monetary variables and providing a survey

⁴ The Energy Research Centre contained a small nuclear reactor (that is still in use). It is located in Petten in a quite part of the Northern dunes of the Netherlands, close to the North-Sea.

of economic developments in the recent quarter. Many of these data had to be seasonally adjusted. That is why Fase and his team paid ample attention to methods of seasonal adjustment (see Fase et al. 1973). A major problem for modelling the real sector of the economy was that the Central Bureau of Statistics (CBS) did not publish quarterly data on the National Accounts in these days. It implied that ESS itself had to construct these data for its modelling exercises.

Thus learning about the techniques and skills needed for structural modelling and learning what problems could be encountered in a concrete case, the team acquired skills that were needed for constructing and managing structural models based on time series data. In the process, the team put itself at arm's length from the existing research department. Its needs for data-collection and maintenance, for software and programming, and its computational needs in terms of hardware, did not match with the existing organisational structure of the research department and so had to be created, either within the Bank, or acquired outside of the premises of DNB, as in the case of its remote access to software and computational capacities at Petten.

The links between the normative and the model based analysis

It thus became a major problem for ESS to get its “new” ideas and ways of working accepted by the management and senior staff of the Bank. ESS followed two routes. The first was to gain international credibility for its modelling work. The second was to connect its modelling exercises to the existing monetary analysis with the Bank.

The first route moved the team in fact in a further isolated position to the rest of the research department. Fase and his team tried to establish credibility for their studies by publishing in international academic journals. Members of the team frequently presented papers at international scientific conferences (such as the meetings of the Econometric Society) and at seminars organised by other central banks. As a result, there was little discussion and interaction between new and the existing research staff, even though ESS also published in locally based journals such as *De Economist*, *Maandschrift Economie* and *Economisch Statistische Berichten*, journals that had published the discussions on Holtrop's monetary analysis between the major Dutch economists. (e.g. Tinbergen, Witteveen: see Bos, 1956 and Klant, 1966 for summaries of the discussions). Members of the research department moved only occasionally to ESS and vice versa.

The second way to try and get the work of the team accepted within the Bank was to link it as much as possible to the monetary analysis of Holtrop and its underlying philosophy. This was done by a direct econometric test of Holtrop's model (i); by giving detailed attention to channels of monetary transmission (ii); by estimation of the elasticities for the demand of

money (iii), and most importantly by a model specification that would endogenise the causes of money creation from Holtrop's analysis.

(i) An example of the first strategy is Den Butter (1979). Just as Duisenberg had made an econometric estimate of Holtrop's formal model in the early seventies, so did the study of Den Butter use modern time series analysis to reconsider the empirics of Holtrop's monetary impulse model. Apart from sorting out simultaneity problems in the data that had not been considered in the modelling exercise and allowing for much more sophisticated lag mechanisms, the conclusion of Den Butter's exercise was unfavourable for Holtrop's analysis, as neither of the monetary impulses distinguished (domestic and external) showed significant results and so a more refined analysis was needed to analyse channels of monetary transmission than could be provided by Holtrop's model.⁵

(ii) In the empirical exercise described above monetary impulses were considered to influence income. Thus, a major feature of this form of Dutch monetarism is that monetary quantities like (changes in) the money stock and liquidity creation are supposed to have a direct influence on the real side of the economy. In other words, the monetary sector is not only supposed to have influence on the real economy (albeit often in nominal terms, including inflation) indirectly through interest rates but also directly through variables representing liquidity, or in a more broad sense, financial wealth. For that reason this *direct money transmission* has played a major role in modelling of monetary transmission at the Bank. A pilot study of Den Butter (1981) showed that adding various alternative specifications of direct money transmission (other than the monetary impulses defined by the Holtrop model) to an IS-curve of the Dutch economy yielded significant coefficient estimates. With respect to the money stock, M2 seemed to be the best indicator of direct money transmission whereas M3 and a very broad variable representing financial wealth also gave good estimation results. With respect to the asset side of the balance sheet of the

⁵ The model of equations (1) to (4) can be rewritten to give the equilibrium condition

$$\Delta Y = 1/(k+m) (D+E).$$

This equation describes how a change in income depends on the monetary impulses. However, when Holtrop (1972) estimates the empirical relation between ΔY and the monetary impulses:

$$\Delta Y = f(D, E), \tag{5}$$

the monetary condition model changes into a causal model. This causal model now consists of 5 equations, where equations (1) – (4) are definition equations and (5) is a behavioural equation linking monetary impulses to the real economy. The 5 endogenous variables are L_{cr} , L_{act} , D , E and ΔY . The mixing up of the condition model with a behavioural model has been one of the main criticisms against Holtrop's modelling exercise (Selten, 1975). L_{act} is not included in the regression, which now reads

$$\Delta Y = f(L_{cr}, E),$$

because data on Y are used to compute L_{act} . However this simultaneity problem is also present in calculating the external impulse. The analysis of Den Butter takes these simultaneity problems into account but is unable to find a significant influence of the monetary impulses on ΔY when the reference period of Holtrop is extended. The conclusion therefore is that other channels of monetary transmission should be considered than the monetary impulses from the Holtrop model.

banking sector, total domestic liquidity creation provided the largest additional contribution to explaining developments in real income. This empirical study of Den Butter can be regarded as a follow up to Kessler's research on monetary indicators (Kessler, 1974), which was also inspired by the idea of Dutch monetarism that direct money transmission is important.

(iii) Because of the prominent role of the liquidity ratio in the practical assessment of monetary policy it is obvious that much work was done in the early years of ESS on the demand for money (see e.g. Fase and Kuné, 1974, 1975, Den Butter and Fase, 1981). The specification in the literature of the demand for money equation was, in these studies, extended with an additional explanatory variable representing the cyclical situation. It was in accordance with Holtrop's analysis that the phase of the cycle was assumed to have an influence of its own on money demand, in addition to the interest rate, the price level and real income as explanatory variables. Indeed, significant coefficients were found for this variable. The most important question to be answered by these demand for money studies was, however, about the income elasticity of the demand for money. As mentioned before, the use of the liquidity ratio as monetary indicator assumed an income elasticity of unity. However, in most of the early demand for money studies of Fase and his team, an income elasticity somewhat below unity was found. The implication for monetary policy was that, in order to be non-inflationary, liquidity creation should be moderated so as to conform to decreasing values for the normative liquidity ratio.

The monetary model and the system of sector balance sheets

The focus of monetary policy on the liquidity ratio in the 1970's implied that money demand should be given a prominent place in the monetary sector of the Bank's model. The demand for money equation can be regarded as empirical representation of the LM-curve, where money supply is assumed to be given. In this way the money demand function describes the feedback mechanism from the real economy to the financial world. The link with Holtrop's monetary analysis is that the demand for money function shows how much money is needed in order to accommodate the transactions demand, given the stance of the cycle, and not to disturb monetary equilibrium. In line with theories on financial model building (Brainard and Tobin, 1968) the monetary sector of the Bank's model was to be based on a closed system of sector balance sheets. It seemed natural that the sectors to be selected should be in accordance with the statistical reporting of balance sheets and balance sheet items in the Annual Reports and Quarterly Bulletins of the Bank. Therefore the following five sectors were distinguished: (i) private sector, (ii) money creating institutions, (iii) central bank, (iv) government and (v) the rest of the world. The latter sector was included to formally close the system. The next step was to decide what items to include in the balance sheets, and more importantly, what items to explain in behavioural equations. In the preparation stage

empirical studies were already conducted with respect to major balance sheet items, namely money demand and the distribution of money demand over various liquid assets (Fase, 1978, 1979b), international capital flows (Koning, 1974), demand for bank credit (Fase, 1979a), mortgage market (Den Butter et al., 1977) and net foreign assets of banks (Den Butter et al., 1979).

When specifying a model based on a closed set of balance sheets, it is important to determine which items are endogenous in the model. Each item appears once on the asset side of a balance sheet and once on a liability side of another balance sheet. So for each item it should be decided whether it is determined at the asset side or at the liability side. Moreover each balance sheet has a residual item and the total closed system yields an additional residual item which is the pitfall in financial model building Brainard and Tobin (1968) report about. In specifying the Bank's model for the monetary sector, the selection of items to be explained by an behavioural equation and of residual items, quite naturally resulted from the empirical studies conducted in the preparation stage. The model was set up in a normalized specification, i.e. each endogenous variable was determined once as dependent variable on the left hand side of the = sign in a model equation. This normalized specification made solving the model rather easy and was in line with the modelling practice of the CPB at that time. It implied that for each market it had to be decided whether the respective balance sheet items were demand or supply determined. Consequently prices and interest rates were determined by the opposite side of the market. So they were reformulated supply equations when the market was specified as demand determined and vice versa. Therefore the model did not describe market equilibriums – as a general equilibrium model does – but only equilibrating mechanisms through the price equations.

A major feature of the Bank's econometric model for the monetary sector (published as Fase, 1981, 1984) was that it provided a behavioural description of all items listed in the traditional table of the sources of money creation. As mentioned before, this was to ensure continuity between the old and the new monetary analysis. But Holtrop himself showed little interest in the econometric approach. For a contribution to a special issue of *Openbare Uitgaven* in 1981, in honour of Goedhart, Holtrop received support from Den Butter. Den Butter considered that it might be appropriate to line out the relation between the behavioural perspective of the Bank's model for the monetary sector and Holtrop's own analysis. Therefore Den Butter (1981b) provided an overview showing how the many variables of the model could be regrouped in terms of Holtrop's analysis of the sources of money creation. It was also shown how the set up of the balance sheet items in the model could bring the table of sources of money creation in accordance with various definitions of money (M1, M2 and M3). Holtrop listened politely to these proposals for the article, but in the end decided differently and had others in the Bank prepare a draft article, that reacted on

Goedhart's ideas of a monetary equilibrium in a dynamic economy. So Holtrop decided to remain within his own territory of Dutch monetarism (Holtrop, 1981).

Tinbergen once remarked that Holtrop did not master the art of econometric modelling, adding that his considerations on the monetary state of the Netherlands had always been profound and instructive (Vanthoor, 1993, 209). One might consider the above anecdote about Holtrop's reaction to the attempt to explicate the relation between his analysis and behavioural economic modelling as an illustration of Tinbergen's judgment. But Holtrop's aversion to the "silly" behavioural equations of the CPB did not mean he was not interested in the behaviour of the agents in an economy, and the motives that gave rise to it. Rather, as explained by Johan Koopmans, he proceeded by a different kind of stories that were crucially dependent on his gifts to detect the clues in the data. We already mentioned Holtrop always wrote the first draft of its annual report during his years as president of the Bank. This then went back and forth between him and the research department. The research department was a sparring partner in sharpening his judgement. But it was *his* judgement nonetheless. At the end of the day, the research department provided him with data that he tackled with his "inductions and deductions" to unravel their hidden secrets. Holtrop's disinterest in the new econometric approach to monetary analysis thus may also reveal his enduring commitment to a research strategy – and concomitant organisation of research at the Bank – that was bound to disappear.

Getting MORKMON at work

After specification and estimation of the models for the monetary and real sectors, there was still a long road to go until the model, which now was given the acronym of MORKMON, was ready for practical policy analysis and could act as a worthy substitute of the conditional monetary analysis of the Bank. An important (and according to the participants in the project most interesting) part of the model construction was solving the model and simulating developments in the observation period in an adequate manner i.e. with relative small within sample forecast errors in a dynamic simulation. The first simulations were, therefore, intended to investigate the dynamics of the model. Did the numerically calculated values of the variables converge sufficiently fast to stable values or not? Were there inconsistencies between the descriptions of the working of the relevant markets in the model? These were among the questions asked. These simulations were combined with a formal analysis of the model structure. This phase of model testing ended with a sequence of critical examinations of a simplified version of the model as to the plausibility of its implied causal structure.

The next phase of model validation regarded the plausibility of the working of the model. The mechanisms described in the model were tested using impulse response simulations.

Here the following questions were asked: What was the model structure? What were the channels through which shocks moved through the model? Is a change needed in the choice of exogenous variables? Are there hidden construction failures in the model? Is there a pattern of autocorrelation of residuals in an ex post forecasting exercise? If so, can we trace this to its source, and use the information to improve the quality and forecasting performance of the model? These simulations helped to further learn about how to use the model in answering real world policy questions. The simulations also contributed to building up skills and the tacit knowledge on how to use the model to tell plausible stories on actual economic developments.

Finally, on 15 June 1984, Frank den Butter and Martin Fase sent a short note to Nout Wellink, then executive director of monetary policy at DNB and from 1997-2011 its governor. The subject of the note reads: “MORKMON and monetary policy (your question)”. It was a very short summary of two simulations performed with the model. The simulations were intended to give meat to the possibilities of using the model for policy purposes, the question raised by Wellink in conversation. These first two simulations of the pilot version of the MORKMON model compared two different instruments of monetary policy on their effectiveness in controlling the quantity of money as measured by M2. In the first simulation the official discount rate of the Bank was raised 1%-point in combination with the same increase of the short term interest rate. The second simulation examined the effects of an exogenous restriction of short term bank-credit of 2 billion guilders in the first quarter of the year. Both simulations were to be included in a monograph on MORKMON that appeared later that year (De Nederlandsche Bank, 1984). They functioned as a kind of show-piece examples to convince Wellink of the merits of the model. That they functioned as such may be gathered from the fact that the notice was cc-ed to eleven staff members of the Bank, the majority of them in its research department. The more extended versions of these simulations (and many others) in the monograph showed that economic policy modelling at the Dutch Central Bank had outgrown its laboratory stage to become an instrument for monetary policy preparation.

But it did not become its only instrument, just as the now well established group of econometricians did not replace, but became a department devoted to *scientific* research separate from the old department of research. Duisenberg, on whose recommendation econometric research had set foot into the Bank, but now, after years in the Government administration as minister of economic affairs for the Social Democrats, in the same seat as Holtrop, put econometric research in its place in monetary policy preparation at the Bank. In his introduction to the monograph presenting the econometric model he wrote: “Postulates and instinct, theories and hunches, econometric models and the backs of envelopes will all make their urgent claims upon the policy maker, but he will need them all.” (De Nederlandsche Bank, 1985). As president of the Central Bank, he identified with Holtrop for

whom the combination of different sources of evidence should trump the simulations and predictions of the Bank's new integrated model of a monetary and real sector of the economy. Yet, on the occasion of the retirement of Van den Belt as director of the CPB, Duisenberg made a comparison between the models for the monetary sector of the CPB en DNB (Duisenberg, 1984). He proudly quoted the renown Dutch econometrician Henri Theil that the CPB had lost its strategic position with respect to DNB, because DNB now also possessed an econometric model, unlike the situation in the 1950's and 1960's.

Van Els (2000, 83), who was closely involved with the model's development and use in a later stage of modelling at the Bank, argued that it is "rather difficult" to "pin down" the exact role of the Bank's econometric model in policy preparation. "Model information is not the only input, but get mixed with other sources of information, part of which will focus on institutional and political aspects". In this quotation we hear the echo of Duisenberg's words written in the foreword of the monograph on MORKMON. Van Elst suspected that this was the case at most central banks, with the possible exception of the Bank of Canada where the model always seems to have played a central role in its monetary policy preparation.

4. Conclusions

It has been argued that Holtrop's monetary analysis, which focused on the conditions for the neutrality of money, lost its meaning by the end of the seventies because general economic conditions had changed so much since the Second World War. To some extent that is certainly true. This paper shows, however, that the introduction of structural modelling within the Netherlands central bank created a new research environment that in a way encompassed Holtrop's monetary analysis. In accordance with updated economic theory, it was much richer in the description of economic mechanisms that play a role in the transmission of monetary policy. These new mechanisms more specifically related to the formal description of economic behaviour, to adjustment dynamics and to the role of prices (including interest rates) in the markets for money, goods and labour. Yet the major philosophy of Holtrop's monetary analysis and the expert judgement on the neutrality of money were preserved in the model. More specifically the ideas of Dutch monetarism incorporated into the model were (i) monetary transmission through channels of direct money transmission (e.g. wealth effects, ease of credit supply) which go far beyond the usual interest rates in the IS-analysis, (ii) feedback mechanisms from the real economic sector determining the demand for money, and (iii) behavioural explanation of autonomous and induced sources of money supply, where the latter can be influenced by instruments of monetary policy and be used to sterilized the autonomous sources, so that monetary policy establishes an equilibrium of monetary neutrality. A focal point in this theoretical and empirical updating of Holtrop's monetary analysis was the definition of money. The model showed how the various components of the money supply and sources of liquidity (or

wealth) creation interacted and were to affect the neutrality of money through transmission to, and feedback mechanisms from the real economic sector. This emphasis on the definition of money and on the determinants of the demand for money accounts for the fact that the liquidity ratio (or velocity of money) served as the target of Holtrop's monetary decision making.

With the emergence of the integrated model, the relation between the president of the Bank and its research department changed even when it is difficult, as Van Elst suggests, to pin down exactly where and how to locate the influence of the model. Once the model was there, it was no longer the president of the Bank who decided what causal influences were important and how these might change sign, depending on the circumstances of the moment. Rather, the web of causal relations was fixed in the model's structure. Those who had developed the model and ran the simulations knew its limitations and, reading the memoranda, listed them as extensively as they could. This created space for the use of other sources of information to modify model outcomes. Yet, it would be difficult to simply reverse the causal narratives that it produced. Even when judgement legally remained with the Bank's governor, materially it had been relegated to an important extent to the econometric model, and to the separate department that was established to develop, manage and maintain it. Model stories replaced detective stories. These model stories at DNB have, for a long time, been based on various versions of the MORKMON model which was only in 2011 replaced by the DELFI model (de Nederlandsche Bank, 2011).

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